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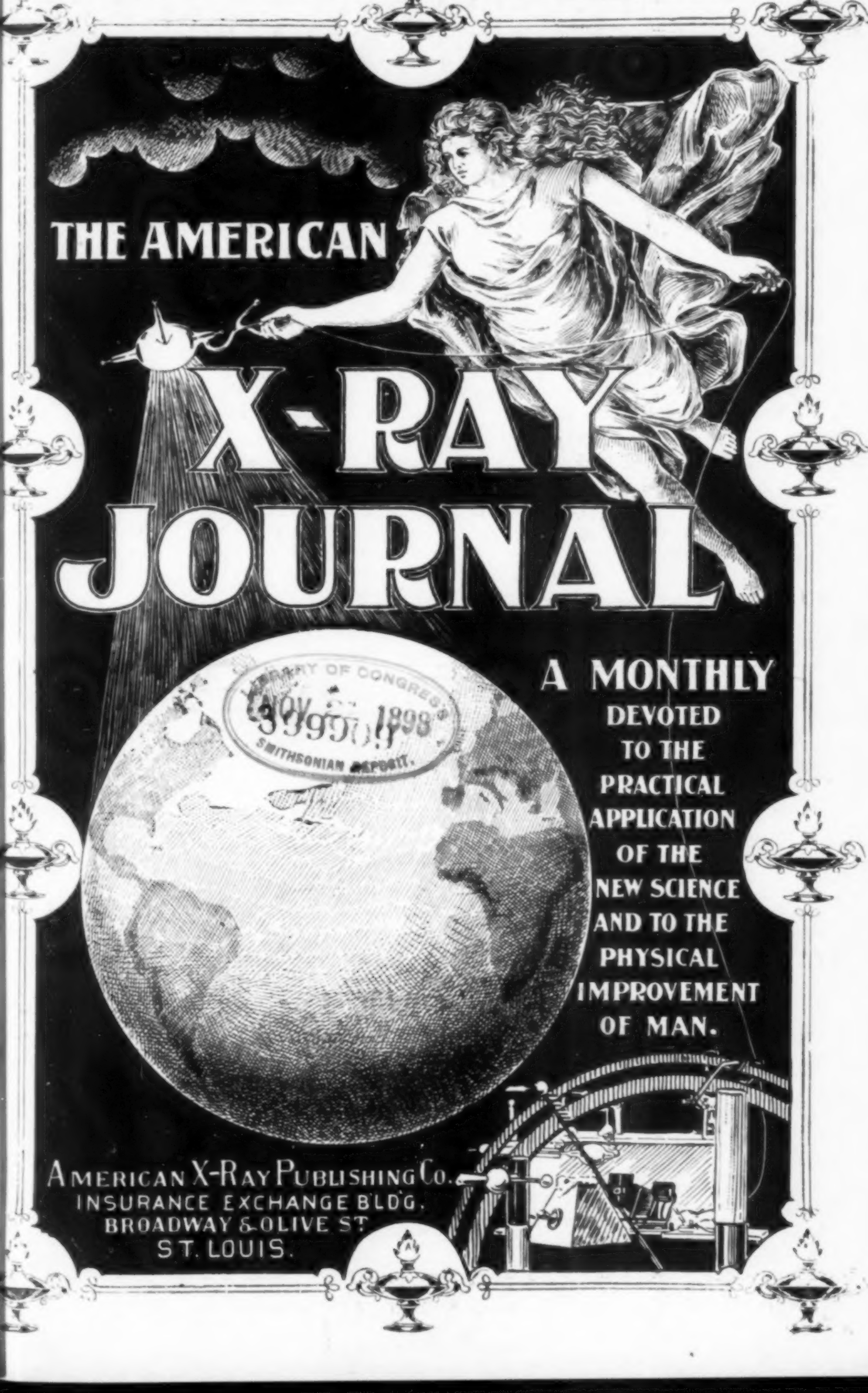

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ROENTGEN RAY BURNS.

BY ELIHU THOMSON.

So much difference of opinion has been manifested by various writers who have considered the now rare injuries produced in x-ray experimentation, that it seems desirable that a clear expression of the writer's experience and opinion on this subject should be made. This is particularly the case since, in a number of cases, opinions and conclusions have been attributed to him which are not in his judgment, tenable in view of the facts.

Many writers have put forward with much emphasis the statement that the so-called x-ray burns are not produced by rays from the tube, but by electrostatic discharges to the skin surfaces owing to too close proximity to the tube in working. Others have said that ozone given off near the tube is to blame, &c., &c.

Various preventatives and remedial agents have been recommended, generally based on the idea that radiation of the nature of the x-ray was not the cause of the injury.

The writer's further experiments tend to confirm him in the opinion which he expressed when his first experiments were published, namely: That the burns *are produced chiefly by those rays of the x-ray order which are most readily absorbed by the flesh.* Such rays are sent out in large amount when the vacuum in the tube is too low or when the tube is "soft", to use Prof. Roentgen's recent designation. A "hard" tube or one with a high vacuum and requiring a high potential to work it will give rays that pass freely through flesh, and not being absorbed by the skin, can not of course do injury.

It is now quite well known that a gradation of quality, particularly as to penetrating power, is possessed by x-rays; that every tube in action evolves rays of low and high penetrating powers in varying amount according to the degree of vacuum and other conditions. This means that rays readily absorbed and

those not so readily absorbed come together from the same tube.

To avoid any risk of x-ray burns even with prolonged exposures we must work the tube at such a high vacuum as to give rise almost entirely to rays of great penetrating power, or non-absorbability; or we may interpose between the tube and skin surface a screen which will cut off the more injurious rays by absorbing them.

However, with such tubes as are now in use and with the relatively brief exposures needed, the danger of causing injury is indeed practically of no importance. There is in fact no danger except in exposures at quite short range and lasting for an hour or more The idea that the trouble is due to electrostatic discharges was effectually disposed of by the writer nearly two years ago, when after having made an experiment with the little finger of the left hand with quite severe results, he repeated the experiment with modifications upon the adjoining finger. This was protected by sheet lead which had a window cut in it so as to limit the effect of possible burns to a small elongated spot. This window in the sheet lead was divided by a strip of tin-foil lying close to the finger and in one of the divisions, so made the finger was covered by a double layer of aluminum foil the other division being left bare. An exposure for a short time to the rays of a special tube constructed so as to enable quite close approximation to the platinum anode target was followed in about ten days by two small burns, one on the part which had been under the aluminum foil and the other on the bare spot. It is inconceivable that any electro-static effect could have acted through the aluminum alone more than through the tin-foil, or more than through the sheet lead, as all three of these metal layers were in electrical contact and subjected to the same conditions. Electro-static effect, or electro-discharges were plainly ruled out. These results were widely published and should have settled the question of ozone, chemical effects, electro static discharges, &c., but from the persistency with which some writers attempt to clear x-rays of all kinds from all blame by assuming causes instead of experimenting to find the true cause we have been led to reiterate with emphasis the conclusion that certain kinds of x-ray radiation do cause burns if the exposure has been sufficient

Equal persistency is sometimes displayed in giving publicity to the statement that tubes worked by static or influence machines can not cause burns, while the fact is that a very severe burn was produced in only twenty minutes upon the writer's little finger, by a tube excited only by a static machine but which was of a power in watts of energy comparable with that of a small induction coil. This was more than two years ago, and the present peculiar livid scar still attests the severity as well as the peculiarity of the injury suffered. To meet the issue squarely and face the real facts will advance the science and give less cause for regrets, for in this case as always, "forewarned is forearmed".

The writer more than a year and a half ago exposed a healthy active mouse to the rays of a powerful tube for an hour. Between the mouse and the tube was a stout iron wire netting of about ⅜ inch mesh. This would only stop a small fraction of the rays but would screen the electro-static effects of brush discharges, particularly as the mouse was enclosed in a box covered by the netting. During the exposure the mouse did not seem to suffer discomfort. A few hours after the exposure it seemed to mope, failed to eat or drink and died during the second day. This experiment is of course not conclusive, as other causes may have interven-

ed to cause death ; but the result at least raises a presumption of injury by certain of the rays such as would be absorbed in passing through the body of the mouse.

When the rays from a very powerfully excited tube of medium degree of vacuum are passed through sheet iron the thickness of which may be increased gradually by adding sheets, it is found that while the addition of sheet after sheet rapidly cuts down the effect of the rays reaching the fluorescent screen back of the layers, there remains a certain proportion of rays which pass through quite a number of sheets. These are the more penetrating rays. By allowing the vacuum to rise and forcing up the potential so as to keep the tube in work the proportion of rays which get through without absorption is seen to increase greatly. The increase is all the greater no doubt because the highly penetrating rays in passing the fluorescent screen give little fluorescence owing to their not being absorbed by the substance of the screen. They give little photographic effect, and for the same reason. This leads to a curious speculation as to the possibility of obtaining rays of such high penetrating power as actually to pass a fluorescent screen without causing fluorescence or a photographic film without acting upon it. The action on the plate and the fluorescence of the screen are due to energy absorbed and converted into chemical action in the one case or light in the other, and if non-absorption be a characteristic of any order of rays evolved, their presence would be undiscoverable, unless perhaps they retained the property of causing the air to discharge electrified bodies, called ionization.

The injuries to the skin are in like manner due to energy absorbed and those rays which pass through the flesh freely are doubtless incapable of doing any injury.

Lynn, Mass

ROENTGEN RAY DERMATITIS.

BY CHARLES LESTER LEONARD, A. M., M. D., OF PHILADELPHIA.

Assistant Instructor in Clinical Surgery and Instructor in Skiagraphy in the University of Pennsylvania; Skiagrapher to the Uni. Hospital; Associate of the Pepper Laboratory of Clinical Medicine, etc.

In accounting for the inflammatory reaction and devitalization of tissue that follows long exposures to the Roentgen rays we must first eliminate all causes that experience has shown are capable of producing like results under different circumstances.

It is an accepted axiom of surgery that in making a differential diagnosis, all known agents shall be excluded before we can logically base an explanation of a new phenomenon upon the hypothetical action of an unknown agent. We must exclude all facts before dealing with hypothesis.

That electricity is capable of devitalizing and destroying tissue is well known. It must be first proved that the Roentgen ray dermatitis is not the result of this devitalizing action, before we have the right to attribute it to an unknown action of the Roentgen rays.

It is a physical fact that high potential currents produce static fields of electricity around their paths. Geissler tubes when introduced into these fields without any direct connection light up, giving visible evidence of the presence of electric currents, strong enough to affect the nutrition of any part exposed to their influence.

The physiological study of the action of electric currents shows that at first they stimulate nutrition, but if employed for too long a period or in too great strength, they devitalize and destroy the tissues upon which they act. High potential currents have a more marked effect on tissue than any other form of electricity and are capable of doing more injury.

The various pathological studies that have been made of the tissues upon

which the Roentgen ray has acted, show that the dermatitis produced has nothing in common with the ordinary burn, but that it is a devitalization of tissue which is followed by disintegration and destruction. The long period that elapses before the effects are shown and the longer period that follows before these injuries are healed is strong clinical evidence that it has been a devitalizing agent that has interfered with nutrition and produced the pathological changes.

Whether the Roentgen rays do or do not possess therapeutic properties is still an undecided question; much has been claimed, nothing has been proved. No one has yet produced results that are indisputably the effect of these unknown rays; and until it has been proved that this therapeutic influence is not due to electrical stimulation, and the destruction to its devitalizing action, it ought not to be attributed to the x-rays.

Kummel, of Hamburg, (*cent. fur chirurgie*) showed before the German Surgical Congress the brilliant results which he has obtained in the treatment of lupus or tuberculosis of the skin by exposures to the Roentgen rays. The results are marvelous and show a study of the phenomena attending the Roentgen ray discharge.

If, however, the paper be critically studied we find that all the therapeutic action may be more reasonably attributed to the action of the static currents in the field that surrounds the x-ray tube. Moreover, the whole paper is a series of arguments in support of the therapeutic action of these currents. His best results were obtained by short frequently repeated exposures that never resulted in an active dermatitis. That is, stimulation without devitalization was desired. When any severe symptoms developed the treatment was discontinued until they had entirely subsided. It was noted that when the patient was seated on an insulating stage the effects were more marked and excessive, while long electric sparks could be drawn from all parts of the patient's body.

We thus see that his best results are obtained from the stimulant action of mild currents. That severe effects and devitalization are to be avoided, and that the danger of producing them is increased, and the effect of the exposure exaggerated, by placing the patient on an insulated platform so that the electrical effect is augmented.

It is difficult to understand how the action of the electrical currents so carefully observed could have been overlooked in determining the agent which had produced such valuable therapeutic results.

In discussing the therapeutic action of the Roentgen rays, Edward Schiff and Leopold Freund, of Vienna, state that the intensity of the therapeutic action is dependent upon the volume of x-ray discharge and the intensity and length of its application.

They found that the most energetic action was exerted by a tube of moderately low vacuum energized by a spark of high electro-motive force and amperage, 3½ amp. 12¾ volts at a distance of about four and one-half inches and with a long exposure. The best therapeutic effects were produced by short, frequently repeated exposures at a greater distance from the patient and while the tube was energized by a current of less voltage and lower amperage, 11½ volts and 2 amperes.

In spite of the increased severity of the action produced by the higher amperage current the authors can see but one explanation of the therapeutic properties developed, and believe they are due to the action of an unknown property of the Roentgen Rays.

What is the reason for the excessive action which they found in a tube of low vacuum, closely approximated to the patient and energized by a current of high

amperage? It is that the higher amperage current, which the lower resistance of such a vacuum permits to pass through the secondary circuit, produces a more intense static field around the tube, while its proximity to the patient produces a more intense action on the tissues, which is again increased by a lengthened exposure.

The conditions under which their best therapeutic effects were produced coincide perfectly with this explanation, for they were produced by frequently repeated, *stimulating* exposures while the tube was energized by a current of lower amperage and voltage, and was at such a distance that the devitalizing action of the static field could not be exerted.

If it is the Roentgen ray *per se* that exerts this therapeutic and destructive action, why is it that they find a high vacuum tube, which we know produces the most intense fluorescent effects and has the greatest penetration or Roentgen value, has the least therapeutic value?

The reason is perfectly clear if we give the static electric field the credit for these therapeutic properties. The resistance of the high vacuum tube is too great to permit the flow of a high amperage current through the secondary, and it thus prevents the formation of an intense static induction field about the tube.

All these confirmations of the electrical causation of the Roentgen ray dermatitis and the therapeutic properties that have been attributed to it, coincide with my own experimentation and experience. So long as the secondary spark employed to energize the x-ray tube was low in amperage no dermatitis was caused. These deleterious effects were not produced until after my coil was rewound so that it gave a secondary current of high amperage, which had been found essential to the detection of all forms of renal calculi.

Since the first few cases were accidentally produced, the employment of an aluminum screen attached to a grounding wire, has prevented further injury. By the interposition of such a screen between the patient and the tube the static charge of electricity is collected in it and conducted to earth, while as it is penetrable by the Roentgen rays the fluoroscopic or skiagraphic efficiency is not altered.

The acknowledged protecting power of these screens, is of itself strong evidence that the agent that is at work and is eliminated by their use, *i.e.* the static electric current, is the cause of the dermatitis and the source of therapeutic action.

The deductions previously reported from my own experiments and cases are additional proofs of the correctness of these views. In two cases where it was desired to produce a therapeutic effect the action of the screen was sharply illustrated. When it was employed and the static currents were conducted to earth no 'burn' was produced. On the other hand when it was omitted the static charge collected in the patient and a deep necrosis was the result of the devitalization of the tissues. All the other conditions were identical and the fluoroscopic and skiagraphic quality of the rays was not impaired.

The Roentgen ray dermatitis is very painful in some of its degrees and heals with difficulty. The slight forms are affected by applications of dilute lead water. *Liquor plumbi subacitas dilutus.* Among the various remedies that have exerted some influence in the severer forms are zinc oxide, ichthyol and boric acid ointments with ten per cent of lanoline. The pain of the severest form is relieved by an ointment containing fifteen grains of antipyrine to the ounce.

The following is a summary of my

views on the so-called destructive and therapeutic action of the Roentgen ray:

1. Static electric currents are capable of producing all the therapeutic and destructive changes ascribed to the Roentgen ray.

2. A static field of sufficient strength is always present, when a tube is said to be capable of producing these results

3. Why should we ascribe to the Roentgen ray therapeutic and pathologic effects which the static charges, always present, are capable of producing.

4. It is impossible to produce a 'burn' when a protecting shield of aluminum is employed which collects the static electricity and conducts it by a grounding wire to earth, although the Roentgen efficiency of the ray is unaltered.

5. It is therefore reasonable to conclude that the devitalizing action attributed to the Roentgen ray is due to long continued or intense static charges or currents, while the therapeutic action is the stimulating effect of a mild and judiciously employed amount of the static charge.

6. The therapeutic results obtained are of undoubted value, but that value will be enhanced and its employment facilitated by the recognition of its true physiological source.

1930 Chestnut Street.

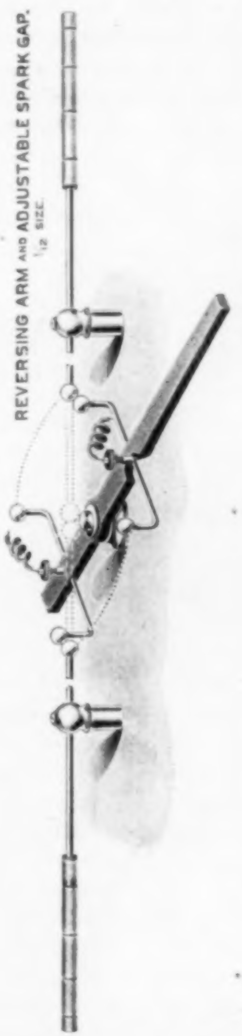
CATHODE RAYS AS CURRENT PATHS. Wiedmann and Wehnelt. *Mitt. Phys. Inst. Erlangen*, March; abstracted in Lond. *Elec.*, Sept. 9. *Electrical World.*—They appear to have established the fact that the great resistance opposed to the discharge by the dark cathode space is greatly diminished as soon as the cathode rays unite the cathode and the anode; cathode rays, in fact, form a sort of conductor, penetrating the dark space. They also use Roentgen and ultra violet rays, but could obtain no diminution in the resistance. They conclude that it is only the paths of the cathode rays which are concerned in the discharge through the cathode space; It does not follow, however, that the cathode rays perform the same function outside of the dark space.

ROENTGEN RAYS. Levy. *Elec. Zeit.* Sept. 22. *Electrical World.*—A reprint of a paper read before the Union of German Electricians, on progress in the technique of Roentgen rays. He first discusses the theory briefly, and then the construction and application of the apparatus as made by him. Regarding the theory, he states that in Germany the tendency is now to favor the theory originated by Crookes, according to which the cathode rays are negatively charged particles, which are discharged at a high velocity from the cathode; their velocity has been calculated, but the results differ greatly; it is, however, likely that it is much less than the velocity of light. J. J. Thomson suggested that these exceedingly small particles are the subdivision of the atoms, and that the properties of these elementary particles are the same. When these particles strike the anti-cathode their velocity is suddenly checked, which produces ether waves of no particular period, which in their properties are analogous to the waves in air due to explosions; these ether waves having no particular period are the Roentgen rays, light rays being periodic. He then discusses and describes the apparatus as he constructs it, an illustration being given. Among the three methods of producing these rays—namely, with the Tesla transformers, the influence machine and the induction coil—he favors the latter, saying that the former is no longer used in Germany, as there are two centers of omission of the rays; to influence machines there are a number of objections, but if these could be overcome they would be a very cheap and good source of the rays.

A REVERSING SWITCH FOR STATIC MACHINES.

BY WILLIAM ROLLINS, BOSTON.

Before a static machine is started only a prophet can tell which terminal will be positive when the machine is excited. On this account it is necessary to have



REVERSING ARM AND ADJUSTABLE SPARK GAP. 1/2 SIZE.

means of easily reversing the current in using a Roentgen light tube. It is also convenient to have the reversing switch act as a double or single adjustable spark gap in series with the tube, because as stated in my notes in the *Electrical Review*, it is better to begin work with the vacuum a little low and get the necessary velocity of impact on the target from the cathode particles by using a spark gap in series. Then as the vacuum rises the velocity of impact can be kept constant by shortening the spark gap thus keeping the character of the Roentgen radiation constant. The accompanying figure shows a convenient switch which meets the requirements. Unless the static machine is very large so that the spark is painful to the ear it is not necessery to bring the terminals in contact as shown by the dotted lines in the figure before reversing the current in the tube, which operation is easily performed by simply moving the handle of the switch through a small arc. If only one spark gap is required one terminal of the static machine is drawn back a little, the amount being regulated by the length of spark gap desired. I have made for my use during the last five years static machines with plates from two inches to six feet in diameter and find this form of switch convenient for any size. The fact that it has been adopted by one or two makers of static machines would indicate that it was practical, and as it has never been described in print it seems worth while to call attention to it.

250 Marlborough Street.

CROOKES' CROSS. Villard. *L'Eclairage Elec.*, Aug. 20. *Electrical World*, N. Y.—An abstract of the French A. A. S. paper. In one of the well-known Crookes experiments a metallic cross is placed in a beam of cathode rays and a shadow is formed on the end of the tube; when the cross is then removed a brilliant cross will appear on a darker background, where the former shadow was. Villard explains this by assuming an increase of temperature of the glass, and describes experiments to show this.

THE DYNAMOTOR.

BY JOHN T. PITKIN, M. D., BUFFALO, N. Y.

It may not be an exaggeration to affirm that the electrologist of the present day finds as profound and exhaustless a field for study and investigation in the structural formation and functional activity of the dynamo as the man of medicine in the corresponding branches, the structures, *i. e.*, anatomy, and the functions, *i. e.*, physiology, of the human body.

It becomes expedient in the study of the dynamotor that we should in the most cursory manner pass in review only the salient features of its more common prototype, show how they differ from each other and point out its field of usefulness.

The Dynamo in its simple form consists of (1) *Field-magnets*, two in number, either permanent of a horse-shoe shape, composed of magnetized steel, or temporary, consisting of a soft iron core, wound with insulated copper wire of a definite size, with a given number of turns in a prescribed manner, the iron core becomes magnetized whenever the electrical current circulates through the bobbin.

The purpose of the field magnets is to establish an electro-magnetic field, a condition of bound or locked electricity, which when undisturbed by conducting agencies circulates between the poles or extremities, through the intervening air gap, invisible to be sure, but always susceptible of demonstration.

The poles or expanded ends of the field-magnets are named, respectively, North and South, inconsistently from the dissimilar magnetic poles of the earth, but as that fact involves the telling of another story, beyond the scope of this article, we must for the present be satisfied with only mentioning the same *en passant*.

(2) *The Armature*, an electro-magnet, made by winding upon a soft iron core, several bundles or loops of wire of a given size, in a prescribed manner, is mounted upon an axis with another structure next to be described. Its function is to react inductively upon the field-magnets and while being rotated in the air gap intercept the electro-magnetic lines of force. In accordance with the law of Michael Faraday which says, "The total electro-motive force induced at any moment in a closed circuit is equal to the rate of decrease in the number of magnetic lines of force which pass through the circuit." (The one form of electricity being thus converted into the other).

(3) *Commutator*, several small metallic segments of a ring, insulated from each other, but connected electrically, to the ends of the armature coils, it is placed to one side of, but on the same axis with the armature, much as a ring is worn upon a finger near the body of the hand; its purpose is to render a current otherwise alternating unidirectional.

(4) *Brushes*, two in number, to bear upon the commutator, at two opposite but definite proportions of its circumference; they afford a place for the attachment of wires to conduct the current generated by the other portions of the dynamo into an external circuit.

VARIETIES OF DYNAMOS.

Dynamos may be classified according to the method employed in connecting their integral parts, into, (1) *Series wound*, in which the current from one brush may be considered as passing seriatim, through external circuit, field-magnets, second brush, armature to the first brush, the point from which we started, thus completing the entire cycle.

(2) *Shunt wound*, each brush delivering the major portion to the external circuit and a minor portion to the field-magnets.

(3) *Compound wound*, involving a com-

bination of the two preceding methods.

It is almost needless to say that each method has its advantages. Dynamos of the first and second variety are not self regulating, but lose in potential, after a certain limited demand is made upon them. The third variety, the compound wound, on the other hand, maintains a constant potential under ordinary circumstances, irrespective of variations in demand caused by the turning off or on of lights or secondary apparatus, for the why and wherefore the reader is most respectfully referred to text books upon the subject.

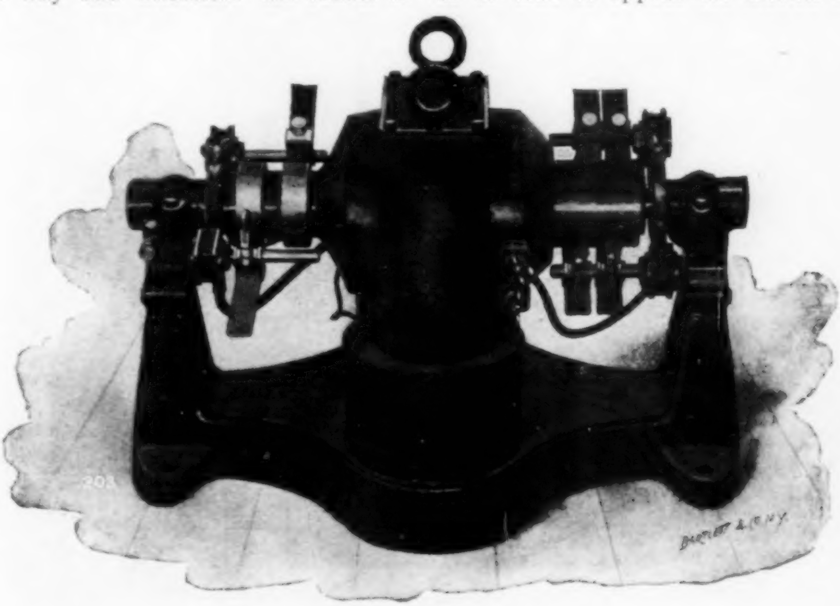


FIG. 1.

Size 5 C.-W. Dynamotor, Low Voltage and Low Frequency, Alternating Secondary.

A FIELD OF ELECTRICAL FORCE.

The armature of an unexcited dynamo which has been at rest, can for a time be turned upon its axis by a little child, but soon there develops a resistance to rotation which the child can not overcome; a man's strength is required; a little later the man in turn finds himself no longer able to overcome the increasing resistance, a steam engine of several horse-power becomes necessary. What has caused the difference in the amount of mechanical energy requisite for its propulsion ?

The electro-magnetic lines of force which increase in number and power, tend by the attraction of opposite poles in the armature and field-magnets, (the former induced, the latter practically permanent,) to hold the armature in a stationary position, in accordance with the law of Lenz which says, "Induced currents are always in such a direction as to tend to oppose the motion that gave rise to them." Nearly the amount of mechanical energy expended upon the excited dynamo above the amount necessary to revolve the armature of one otherwise dormant will correspond, to electrical output, its so-called, transforming or generating capacity, the unit of which is called a kilowatt (one thousand watts). Not because mechanical energy is directly converted into electricity, but rather is employed to cause an electro-magnetic disturbance of equilibrium in the atmosphere sur-

rounding the apparatus resulting in its excitation or a (so-called) electrical flow.

We are forced to employ the time honored expressions, generate, electrical current or flow, etc., etc., more or less figuratively for descriptive purposes. There probably is not any such process as the terms imply. It has never been proven that there is any electrical flow, and even supposing the condition possible, we would be ignorant as to its direction. There is, however, *a field of electrical force*, consisting of lines and tubes of energy as first explained by the celebrated savant Maxwell, which by its activity causes a condition of charge and discharge, excitation or quietude of the electrical apparatus and its environment.

EXPLAINS THE ACTION OF THE ARMATURE.

As the armature of a dynamo is revolved, its coils of dissimilar phase or polarity are removed farther from the attracting field-magnets and as they are good conductors they become channels of less resistance than the increasing air gaps; thus they divert the electrical energy into an external circuit.

While the armature of a dynamo is quiet its potential may be considered at zero, but it will gradually rise in proportion to the rapidity of revolutions, strength of the field-magnets, and the number of turns of wire upon the revolving axis. It is obvious that increasing the strength of current in the primary, rapidity of its interruptions or the rate of rotation of a secondary coil has within certain limits, the same effect in the production of electro-motor force, by induction, as increasing the number of turns of wire in the armature or secondary; this fact will often enable us to dispense with expensive, cumbersome or multiple secondary coils.

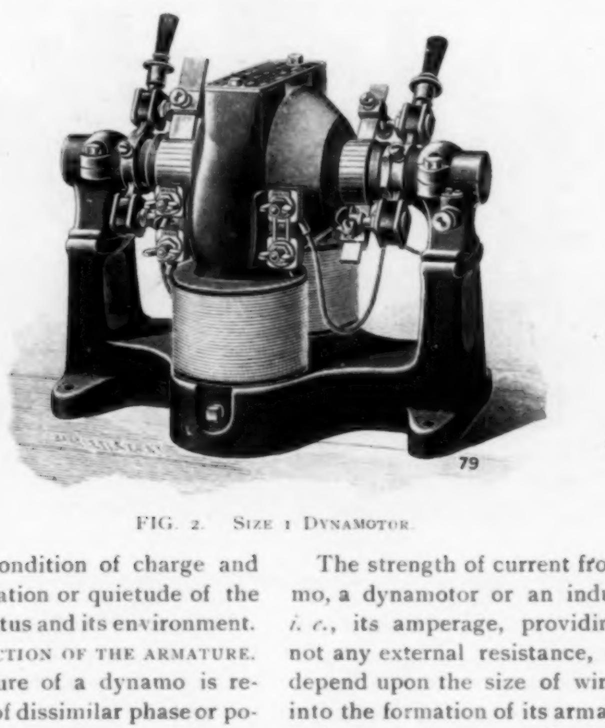


FIG. 2. SIZE 1 DYNAMOTOR.

The strength of current from a dynamo, a dynamotor or an induction coil, *i. e.*, its amperage, providing there is not any external resistance, will largely depend upon the size of wires entering into the formation of its armature or secondary, one bearing a direct ratio to the other.

THE ELECTRIC MOTOR.

If a secondary dynamo is placed within an electrical circuit of suitable strength, the electro-magnetic lines of force will cause its armature to rotate; it is then capable of performing mechanical work,

e. g., turning the revolving plates of a static machine, and is called a motor.

When a motor or secondary dynamo has wires attached to the brushes and a current is thereby shunted off from the armature to be employed for various purposes, it is called a dynamotor.

THE DYNAMOTOR AND ITS MODIFICATIONS.

The dynamotor or rotary transformer may have one portion of its armature coils terminate in a commutator, on one side, as usual, and a second set of ical batteries formerly used at the central stations. It is in this manner that not only the short lines in the city of Buffalo are excited but the long distance wires between this place and Chicago, New York City, Boston, Philadelphia, Toronto and other remote and intermediate places receive their electrical supply, indirectly from the dynamos of the great Ellicott Square Building, the down-town home of the Buffalo Electrical Sanitarium.

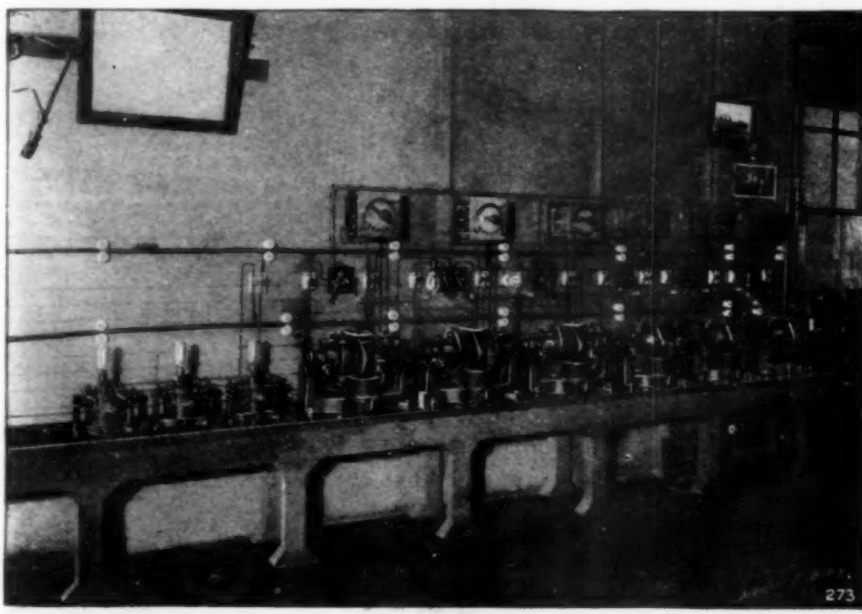


FIG. 3.

Electrically Driven Telegraph Plant 20 Dynamotors. Western Union Telegraph Co., Buffalo, N.Y.

larger wires terminate in a second commutator on the other, in order to deliver two currents of different strength from the same instrument, or, instead of the second commutator two collecting rings may receive the ends of the coils of wire of opposite phase, giving rise to the alternating or sinusodial current. The former variety of dynamotor is employed in the telegraph, the latter in the telephone service, where they have entirely replaced the great number of chem-

Through the intervention of the dynamotor the direct current may be transformed into the alternating or vice versa, (see cut No. 1.) a direct current of high potential and little quantity into one of low potential and greater quantity, (Fig. No. 2.) or any other combination desired by the operator, the number of watts or total electrical energy being always nearly the same, a little energy is necessarily lost during the transforming process by induction, (be it ei-

ther up or down,) in making the interchange.

THE DYNAMOTOR VERSUS THE INDUCTION COIL.

In the study of the structure and function of the dynamotor one may consider it as the modification of the common induction coil, *e. g.* Faradic or Ruhmkorff. The field-magnets are the analogue of the primary coil, and its soft iron core, the armature is the homologue of the secondary, the effect obtained by revolving the armature of a dynamotor results in the induction coil, from making and breaking the primary circuit at the interrupter or rheotome. For the thorough understanding of the process of induction upon all electrical devices we must not only try to comprehend what occurs in the conductors but also the condition of stress, or strain caused by the lines of force in the dialectric atmosphere, in the air gaps surrounding the apparatus and external circuit.

UTILITY OF THE DYNAMOTOR.

When the armature of a dynamotor is at rest its potential is nearly zero, but it will gradually rise with the increase in rapidity of revolution; it is governed in the same manner previously explained for the action of the armature of the dynamo. If a current from a bank of lamps is supplied to the field-magnets, suitably wound, the armature of the dynamotor will revolve with increasing rapidity and if there are many turns of wire entering into its formation, the voltage will rise with each additional lamp turned on, the range of potential being from one to eighty volts, which is all the electro-therapeutist can desire for the galvanic treatment of chronic diseases. It must be borne in mind that the current's strength of any electrical device bears little relation to the same after the resisting tissues of the patient have been placed in the circuit; it becomes in accordance with Ohms' law, a

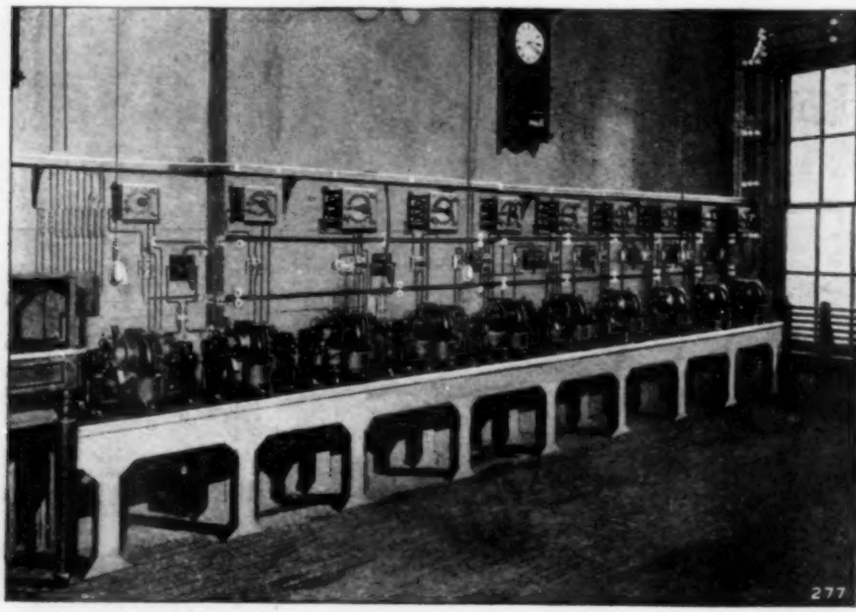


FIG. 4.

Electrically Driven Telegraph Plant. 20 Dynamotors. Western Union Telegraph Co., Buffalo, N. Y.

question of voltage or pressure of the current divided by the resistance of the patient's tissues in ohms, interposed between the electrodes. The tissues may be good or poor conductors, depending upon the amount of moisture and salts they contain on the one hand and the tension of the current on the other, the higher the electrical potential the better conductor the human body becomes. When, however, we desire to employ the undulatory or interrupted galvanic treatment, additional strength will increase the so-called extra current, and the amount of shock with each pulsation.

AN IMPROMPTU DYNAMOTOR.

Any ordinary fan motor wound for the one hundred and ten volt direct current of the Crocker-Wheeler, or Lundell make, becomes a dynamotor by attaching conducting wires to the brushes suitable to galvanize the patient, placed in simple series with the electrodes, a milleamperemeter in the circuit will read from one to fifteen milleamperes according to the rate of rotation of the armature and the conductivity of the tissues. This current may be employed in the removal of superfluous hairs. The electrical needle should be attached to the negative or cathodal pole, and inserted into the hair follicle, while the indifferent, positive or anodal pole is held in the patient's hand. The needle may be replaced by the electrical knife, and employed to remove other facial blemishes or the same current used to convey chemical medicaments into the tissues, the poles being selected with a view to their electro-chemical properties, by the process of cataphoresis.

ADVANTAGE OF THE DYNAMOTOR.

As the dynamotor is wound to deliver a given quantity and quality of electricity it does away with costly, wasteful rheostats which reduce the current's strength, by converting a portion of the electrical force into some other variety of energy; it also lessens the danger of shock to the patient, which may result from an accidental overloading of the primary circuit.

HOW TO DETERMINE THE POLARITY.

The polarity of the current from a dynamo, motor or dynamotor can be ascertained by suspending with a flexible cord, a horse-shoe magnet, so that it is free to move in the lines of force an inch or two above the machine; the magnet will first oscillate, then come to rest with its North pole pointing toward the negative brush of the instrument.

In conclusion let me say that the dynamo in all its varied forms finds its place in the armamentarium of the modern electro-therapeutists; it delivers to the patient currents of a definite strength which are employed for definite purposes, with the milleamperemeter and volt meter always in the circuit and before the eyes of the physician informing him as to the quantity, quality and total number of electrical units (watts) of the current, he obtains therapeutical without toxicological effects.

Quantity is used for x-ray and cautery work, preferably from the alternating service. Moderate tension for galvanization of the patient. Unidirectional for polar effects. Sinusodial for the see-saw stimulation of dormant organs, before or after passing through the high potential transformer. "The poor man's electrical bath" of Tesla.

CATHODE RAYS. Jaumann. *Wien. Akad. Sitzber.*, 106, p. 533; abstracted briefly in *Science Abstracts*, June.—He describes more fully the details of his experiments with the interference of electrostatic deflection of these rays.

STRUCTURE OF CATHODE LIGHT. Goldstein. *Berlin Akad. Sitzber*, 40, p. 905; abstracted briefly in *Science Abstracts*, June.—He describes the three distinct kinds of radiation.

Methods of Precision in Locating Foreign Bodies in the Head by Means of the Roentgen Rays, with Special Reference to Foreign Bodies in the Eye.*

BY CHARLES LESTER LEONARD, A. M., M. D.,
Skiagrapher to the University Hospital; Assistant Instructor in Clinical Surgery, University of Pennsylvania.

The enthusiasm which greeted Roentgen's discovery of the x-ray has somewhat abated. A reaction has taken place, and we are now in a position to judge more accurately of the true merits of this method of diagnosis.

It is, however, with special reference to its use in determining the location of foreign bodies in the eye that I desire to call your attention. Many instances have been cited by reliable authors in which it was impossible to find the foreign body "located" by the x-ray, and with rather hasty judgment they condemn the entire method, and say that it is only useful in determining the presence or absence of the intruder, and that localizations are often more misleading than helpful.

They condemn the entire method because, in certain specific instances, it has not been employed in a sufficiently accurate manner to produce precise results.

It is impossible to make accurate measurements of any description by inaccurate methods, or with instruments lacking in precision, and until we apply to localization by the Roentgen rays accurate methods and precise instruments we cannot expect precise results. We must not condemn the method because, when improperly applied, it does not produce satisfactory results.

Among the conditions which add to the difficulties of accurate localization by the x-rays is the fact that it does not produce an absolutely true image. The skiagraph is a shadow cast by rays emanating from a point. The bundle of rays which project this shadow is, therefore, made up of rectilinear divergent rays, and the shadow must, consequently, be larger than the object. Not only is this true, but the parts lying at a greater distance from a point where the rays strike perpendicularly are more distorted. The farther the tube is placed from the object skiagraphed the less distortion will there be produced, as the rays forming the bundle will be more nearly parallel.

The difficulties met with in applying methods of precision to the location of foreign bodies in the orbit, and in eliminating from such observations all sources of error, have led me to bring before you an apparatus for maintaining the foreign body in a fixed relation to a definite point in a known plane, corresponding to a point marked upon the skin of the patient, while a sufficient series of observation are made by the x-ray upon photographic plates, to determine the relation of the foreign body to the point upon the skin and the known plane containing it. During these observations the tube has an altered, yet definitely determined relation to the known point, and from the data obtained we are able to construct a series of triangles, the relational sides and angles of which can all be determined, while the third sides all contain the foreign body, since they are projections of its shadow.

The location of the foreign body, since it lies in each of the third sides, must be at their intersection, and since all the factors of these triangles are known, the absolute location of the foreign body can be mathematically proved. The principle involved in the calculation of the relation of the foreign body to this point in a known plane, from the data that are thus obtained, is identical with that of the method described by my friend, Dr. C. A. Oliver, before the American Oph-

*Paper read before the February meeting of the Section on Ophthalmology, College of Physicians, Philadelphia.

thalmological Society in May of last year.

The same principle is equally applicable to the location of foreign bodies anywhere in the body and always has the advantages of simplicity and infallible mathematical accuracy. (See *Annals of Ophthalmology*, Vol. VI., No. 4.)

Many other methods have since been brought forward for locating foreign bodies in the eye, based upon mathematical calculations from a series of observations on one or more photographic plates. Their chief fault lies in the fact that the majority of them base their calculations on points situated too near to the plate, so that their calculations are based upon measurements so small that an error that would be inappreciable in greater distances has a very marked effect upon the final result.

The great advantage of this method over any of these is, that the great distance between the points on which the calculations are based, usually twenty inches, minimizes the effect of any slight error made in taking the observations, while the fact that the localizing point is upon the skin of the patient is a marked advantage over all the methods that attempt to measure from any point upon the eyeball.

In this method any error produced by the movement of the eyeball affects only the foreign body, while in methods based on measurements from a point on the ball, the known point will be moved as well as the foreign body, and hence the error would be double in its effect.

In order to avoid the errors introduced by unconscious movements of the patient, as in respiration, the whole apparatus has been constructed in such a manner that its relational parts are rigidly connected, while the whole is firmly fixed to the individual. Any movement communicated to one part must affect the whole equally and does not alter the known relations of the tube, the foreign body, and the known point, or affect the final result.

The apparatus consists of a yoke that is firmly fastened to the shoulders of the patient. Upon the yoke and adjustable in two directions is an upright frame, which serves to hold the head of the patient in a fixed relation to the plate, which it also supports. On the upright frame is an adjustable arm, which carries the x-ray tube. Its angle, relation to the common base (the photographic plates) is variable, in a perpendicular plane and thus it is capable of forming one of the known sides of a successive series of triangles, whose varying third side is the line of the projected shadow of the foreign body.

By a subdivided arc, situated at the juncture of this movable arm and the common base of the triangles, *i. e.*, the frame supporting the plates, the relational angle in any position can be definitely determined, and, consequently, from the two known sides and included angle all the relational sides and angles of any one of the series of triangles may be constructed.

The apices of these triangles are at a point on a line connecting two lead ferrules that slide upon an aluminum wire, and at a known distance from the ferrules. The wire and ferrules are situated in the planes of the movable arm and the frame, and determine the apices of the successive angles made by them, by casting the shadow of the lead ferrules on the photographic plate outside of the field of observation.

This point is, therefore, readily determined upon the plates, and its distance from the upper lead ferrule, when added to the distance of the ferrule from the lower surface of the movable arm, should equal the distance of the focal point of the tube from that surface. The tube is thus placed in a plane of this known point, perpendicular to the surface of the photographic plates. From this

known relation of the tube to the known point on the plane of the plates we are able to determine the distance of the foreign body above or below this plane.

The device for holding the plates permits the interchange of the series without any disturbance of the fixed relation of the foreign body, the tube, and the known point. The fixed relation of the tube, patient and plate, gives the skiagraph increased definition, as every movement communicated to the head, or plate, is equally communicated to the tube.

By using this rigidly connected form of localizing apparatus we have eliminated from our observations errors which might arise from the following sources, alterations in the relation of the foreign body to the fixed known points, alterations in the relation of the tube to this point, during an observation, through unconscious movements of the patient, alterations produced in the interchange of the photographic plates, and errors due to the obscuring of any portion of the field by the localizing apparatus.

The only remaining source of error is the unconscious motion of the eye. This is a frequent source of error, which I have seen entirely destroy the image of an object whose presence a succeeding series of observations absolutely demonstrated. The best method of overcoming this error is, as many writers have shown, the closure of the eyes.

Attempts to fix the eye upon a definite point are generally failures, as the eye does not sustain the strain readily, and unconscious movements, as in winking, are certain to occur. With the eyelids closed, the eye remains quiet, and its position can afterward be readily determined by observing the prominence of the cornea through the eyelid.

The great advantage of this method is its simplicity and infallible mathematical accuracy.

The method of employing the apparatus is the following: The patient is seated in a chair, the yoke fastened to his shoulders, and the upright frame placed tightly against the temple, with

FIG. 1.

the head held in position by the band attached to the frame. The fixed point is marked and the tube adjusted in a plane perpendicular to the photographic plate at the known point. The plate is then placed in position. The tube upon the adjustable arm is placed at an angle appropriate to the individual case, the angle noted, and an exposure made; a second plate is then substituted, the angle changed and noted and the exposure

made. These exposures are repeated at different angles as often as may be necessary; two, however, usually suffice to give absolute localizations. After the plates are developed the distance of the shadow of the foreign body from the known point is carefully determined, and with the angle and known side in each observation give the data upon which the calculations are based.

The practical determination of the location of the foreign body is greatly simplified by substituting for the mathematical calculations the following graphic method:

The common side of the successive series of triangles, *i. e.*, the series of photographic plates is represented by a part of the line P.P.', (Fig. I.) A point, A, represents the location of the common apices of the series of triangles; on known sides, the distance of the tube on the adjustable arm, is represented by the known sides A B and A C of the series of triangles having for each triangle a known relational angle to the base line, *i. e.*, the angles P' A B and P' A C, etc. The distances, A D and A D', are found by measuring the perpendicular distance of the shadow of the foreign body, in the respective plates, from the line that connects the known points. Lines connecting these points B and C represent the projection of the shadow of the foreign body, which must, therefore, lie at the point of their intersection, X.

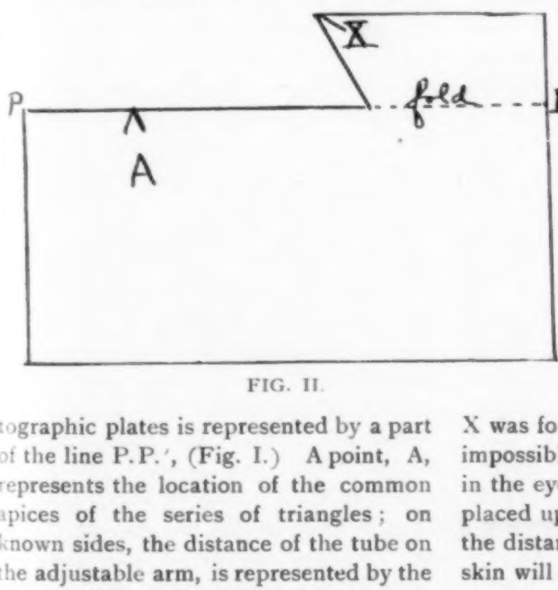


FIG. II.

We have, therefore, by constructing these triangles from the data obtained, definitely determined the relation of the foreign body to the known points and the plane containing them.

The following is a simple method of utilizing the knowledge obtained in locating foreign bodies in the eye: A piece of cardboard is cut (Fig II.) so that the point X has the same definite relation to the point, A on the base line, that it has in the drawing. If the card is now bent to a right angle along the base line, the relation of A and X will not be altered. If it is then applied to the patient's head, with the larger portion of the card occupying the position of the plane of the photographic plates, and the point, A resting at the known point on the patient's scalp, the point, X would rest on the foreign body, since the smaller portion of the card represents the plane perpendicular to the photographic plate in which the point X was found. This, however, would be impossible if the foreign body was within the eyeball. But, if the point, X, is placed upon the surface of the eyeball, the distance from A to the point on the skin will represent the depth necessary to cut to reach it.

These skiagraphs represent some of the instances of localization by these methods without the use of the apparatus. In these cases the plate was bound to the side of the patient's head and the head held firmly by a suitable rest with the patient in a sitting position. The tube was adjusted by angles suitable to the individual case traced upon cardboard, the apices of these angles esting on the plate at a point opposite

the bony orbital margin, while the common side ran parallel to the plate.

The tube was placed successively at the extremity of the other sides, thus two sides and the included angle were known in all the triangles, while the foreign body was situated at the point where the third sides intersected and could be determined mathematically, or more readily by the graphic method.

THE ROENTGEN RAYS IN THE DIAGNOSIS OF PULMONARY TUBERCULOSIS.

At the congress on tuberculosis recently held at Paris, Bouchard and Claude (Paris) presented a long report on the application of the Roentgen rays to the diagnosis of pulmonary tuberculosis. In that disease at the outset the lesions consist of new formations (tubercles, isolated or agminated) constituting an obstacle to the penetration of air, and of congestion of greater or less intensity. At this time the fluorescent screen will show at one apex or both, sometimes at several places in the lungs, small spots, ill-defined at their circumference, or a slight mistiness veiling one apex; in other cases a kind of stippling of small shadows on a less dark ground. Confluent pulmonary infiltrations with a tendency to softening and ulceration give rise to almost complete opacities; these are darker in the case of lobar infiltrations, lighter in the case of lobular infiltrations. The intensity of the shadows is proportional to the defect in the penetration of air into the lung; if the lesion forms a compact, voluminous mass absolutely impenetrable by the air, the darkness shown on the screen is complete; if there is a number of little nodules separated by parts still permeable by the air, the general opacity is less intense and on the dark ground are to be seen deeper shadows corresponding to points completely caseated. The formation of cavities reveals itself on radioscopic examination as on the plate, sometimes by an absolute opacity, sometimes by zones of relative transparency surrounded by spots of variable opacity. Absolute opacity is met with only in the case of cavities full of pus, or when the cavity is deeply seated and surrounded by pulmonary tissue stuffed with tubercles, or when a covering of dense adhesions prevents the passage of the light rays. If, on the other hand, the cavity is superficial, empty, and has a thin wall, it shows as a clear zone when compared with the neighboring parts of the lung more deeply shaded; it is oval in shape, and sometimes the ribs in front of it are visible. When the cavity fills up, the clearness which marks its situation diminishes, and there is only a large shadow, rather less deep at one part than in the rest of its extent. Every degree of variation is possible, but the essential character in all forms of the radioscopic image of cavities is the presence of a very dark zone more or less annular in outline, encircling a region relatively clear or altogether transparent, whilst the rest of the lung in the neighborhood is in shadow. It is a sharp contrast between these two elements of the lesion —spots relatively clear showing on a ground frankly dark, a shadow fining off at the circumference and sharply cut round the central clear zone—that is characteristic of a cavity. The pneumonic confluent form of acute phthisis reveals itself on the fluorescent screen by complete opacity of the diseased parts; this is explained by the fact that at these points the lung is no longer permeable to air. Effusion at the base is shown by a thick shadow which hides the diaphragm, and below is lost in the obscurity of the abdominal mass, and above is limited by a zone of penumbra directed obliquely from above down, from the axillary region to the vertebral column, or in the shape of a curve concave at the upper border. Examinations at intervals of a few days will show

the variations in the extent in the liquid effusion by variation in the extent and form of the shadow. An intense opacity of generally rounded outline occupying the middle part of a lung in which the upper and lower parts have almost retained their normal clearness suggests an interlobar effusion. Here, again, the variability of the shadows at different times is a help to diagnosis. Dense and extensive adhesions of the pleura, on the other hand, manifest themselves by shadows less dark but constant in their form. In such a case it is often impossible to distinguish the condition of parenchymatous lesions by radioscopic examination alone. Pneumothorax is characterized by an abnormal transparency of one side of the chest, which allows the light to pass through without any interference, except over a small area on the affected side corresponding to the retracted lung. The heart and the vessels may be displaced; the curve of the diaphragm is lower than in health. In hydro-pneumothorax and pyo-pneumothorax the appearances vary according to the position of the patient; if he is lying down, the whole of the affected side is dark; if he is standing up, the upper side of the part is more transparent than in the normal state, and the lower is opaque. Even slight tuberculous changes in the pleura affect the mobility of the diaphragm. In general terms it may be said that in pulmonary tuberculosis there is a diminution in the movements of ascent and descent in the diaphragm; this change may be observed on one or both sides. Radioscopic examination can also give important information as to the condition of the mediastinal glands in tuberculous patients. In acute or subacute bronchitis the two sides of the chest show little or no departure from the normal state, and there is no change in the respiratory movements of the diaphragm—negative signs which may be of some importance. In pneumonia there is complete opacity at the part corresponding to the lesion. This opacity, however, varies in its limits and intensity from day to day. The movements of the diaphragm are diminished on the affected side. Non-tuberculous broncho-pneumonic foci cause a slight opacity, but according to Maragliano this becomes less marked on deep inspiration. On the other hand, foci of pulmonary sclerosis, like patches of tuberculous infiltration, do not become clearer on deep inspiration. In simple emphysema the permeability of the lung to air is increased, and thus the transparency is exaggerated, and the ribs are less distinct. Moreover, the emphysematous lung is larger than natural, and extends into the pleural cul-de-sacs, so that the transparent surface corresponding to the organ extends more upwards towards the mediastinum and particularly more downwards towards the abdomen. When the subject is examined at the back there is seen below the diaphragm a transparent surface of much greater extent than in the normal state. The authors conclude that the use of the x-rays makes it possible in certain cases to discover commencing changes in the lungs at a period when other methods of clinical investigation give no indication. In other cases it defines the extent or reveals the importance of a lesion insufficiently disclosed by auscultation or percussion. Again, it enables the practitioner to reject the hypothesis of tuberculosis in cases where symptoms and clinical signs of doubtful import puzzle the clinician; while at the same time it often enables him to trace to their true cause general disturbances which clinical observation has failed to detect. Radioscopy is not merely a method of control, correcting or supplementing the ordinary methods, but it yields new indications. By making visible the working of the respiratory apparatus, it shows the functional value of one lung. It dis

closes the pleural adhesions, the pareses or ankyloses of the diaphragm, which limit the movement of expansion. In a word, it makes the evolution of the disease visible to the eye.

A. Beclere (Paris), in a communication on the same subject, said that for the exact and complete determination of tuberculous lesions radioscopy and radiography should be employed simultaneously. He dealt successively with the results obtained by the x-rays in (1) latent, (2) suspected, and (3) declared tuberculosis. In latent tuberculosis the patient has every appearance of perfect health, and presents absolutely no physical sign or symptom of disease. The frequency of this state of things is shown by the large number of cases among soldiers who have died of various diseases in whom old unsuspected tuberculous foci have been found. Kelsch made radioscopic examinations on 124 men admitted to hospital in October and November, 1897, for various medical and surgical affections, all cases in which pulmonary tuberculosis could be recognized by the ordinary diagnostic methods being carefully excluded. The results were absolutely negative in seventy-three of the cases, but in the remaining fifty-one the fluorescent screen revealed abnormalities of various kinds —lessened transparency of the apices, enlargement of the bronchial glands, more or less marked opacity of the pleura, diminished movement of the diaphragm. These appearances were considered by Kelsch to be characteristic of tuberculosis. He adds that the screen, by allowing, as it were, a pathological examination of the lung to be made during life, confirms the conclusion to which he has been led by post mortem examinations, namely, that in young persons latent tuberculosis exists in at least two or three of every five cases. The use of the x-rays also serves for the identification of tuberculous lesions which disguise themselves under the mask of anaemia, chlorosis, dyspepsia, and neurasthenia. In cases of suspected tuberculosis, if the disease attacks the lung suddenly, radioscopic examination shows chiefly a diminution in the clearness of the image at the apex and in the pushing down of the diaphragm on the affected side. Tuberculosis may begin by an attack of diaphragmatic pleurisy, the symptoms of which are so slight that the only proof that the pleura is involved and that the case is not merely one of intercostal neuralgia is supplied by the Roentgen rays, which show thickening, diffusion, and immobility of the diaphragmatic shadow. If the case is one of dry pleurisy with "stitch" in the side, but without any decisive physical sign, radioscopic examination shows superficial opacities quite close to the thoracic wall. In cases of effusion the condition of the apex in regard to transparency on the affected side must be carefully investigated. Even a slight degree of opacity in the region of the apex is important in regard to prognosis. In declared tuberculosis the lesions are plainly shadowed on the screen. In such cases radioscopy is more valuable for prognosis than for diagnosis; it will show when both apices are attacked where clinical examination appears to warrant the conclusion that one is still intact, or when the lesions extend lower down than is disclosed by ordinary methods. The x-rays are particularly useful for the detection of central lesions, which on account of the depth at which they are situated are apt to be overlooked.—*British Medical Journal.*

Bi-Polar Discharge. Wien. *Wied. Ann.*, No. 6, abstracted briefly in the Lond. *Elec.*, July 15.—He abolishes the distinction between anode and cathode rays, substituting the expressions "streams of positive and negative particles"; that is, it is claimed, shows a vic-

tory of the English view. Both kinds of light contain admixture of particles of the opposite sign, which he shows by an arrangement in which the cathode is put into an out-of-the-way side tube. The anode emits positive particles from its front surface, and the cathode, negative particles; both, if perforated, also emit particles of an opposite sign, though to a lesser extent.

CATHODE RAYS. Jaumann. *Wien. Akad. Sitzber.*, 106, p. a number of articles. One on cathode rays by Wiedemann and Schmidt, from the *Wied. Ann.*, 62, p. 603; another on the relation between the positive light and the obscure cathode region by Wiedemann, from the *Wied. Ann.*, 63: p. 242; another on the mutual influence of the different regions of the same cathode, by Wiedemann, from the *Wied. Ann.*, 63, 246; another on the deflection of the cathode rays by Kauffmann and Ashkinass from the *Wied. Ann.*, 62, p. 588; and another on the magnetic deflection of cathode rays by Kauffmann from the *Wied. Ann*, 62, p. 596.

MUTUAL REPULSION OF CATHODE BEAMS. Wiedemann and Wehnelt. *Mitt. Phys. Inst. Erlangen*, March; abstracted briefly in Lond. *Elec.* Sept. 9. *Electrical World*, N. Y.—Crookes, in his earlier work, believed that two parallel cathode beams were bent aside by mutual repulsion; the present authors repeated an experiment made by Weber, which the latter claims confirms this repulsion, but they obtained the opposite result; under favorable circumstances the rays can be distinctly seen cutting each other in straight lines without a trace of mutual repulsion.

FLUORESCENCE AND ROENTGEN RAYS. Arnold. *Mitt. Phys. Inst. Erlangen*, March; abstracted briefly in the Lond. *Elec.*, Sept. 16. *Electrical World*, N. Y. —He investigated whether the fluorescence of the anti-cathode has a favorable or unfavorable influence on the production of these rays. The anti-cathode was made to consist of a fluorescent and non-fluorescent plate, and a pin-hole camera produced an image of the compound cathode on a sensitive plate. With none of the substances used could any difference produced by luminescence be observed? It appears, therefore, that there is no connection between Roentgen rays and luminescence.

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NOTE.—This is the first instance in which a series of Skiagrams showing the ossification of the bones of these parts has been traced over a period of years from early infancy. Such an atlas must necessarily be of great practical use to the surgeon and student.

LONDON: SMITH, ELDERS & CO.,
15 Waterloo Place, S. W.

THE TREATMENT OF DISEASE BY ELECTRIC CURRENTS.

A handbook of plain instructions for the general practitioner. By S. H. Monell, M. D., Brooklyn, N. Y. Published by William Beverly Harison, 3 and 5 West 18th Street, New York. 1088 pages.

Another extremely valuable work on electro-therapeutics has been launched by the same author as the recent publication, "Manual of Static Electricity in X-Ray and Therapeutic Uses," which has attracted world-wide reputation thus early for its clearness of description, and usefulness to the general practitioner.

It would be impossible for us to specialize the headings of the 70 chapters in this volume in the space allotted for this review, therefore it must suffice to state that every known modern employment for faradic, galvanic and static electricity and their therapeutic indications are detailed in this volume with conciseness of language and minute directness of application, so that the general practitioner may read and understand.

Probably no book on electro-therapeutics, and we say it conservatively, has ever equaled this volume for value to those of the profession who would use electricity as a therapeutic agent, and he who does not use it at this age is certainly not up to the times in his profession.

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